FLAT SOLID ELECTROLYTE FUEL CELL

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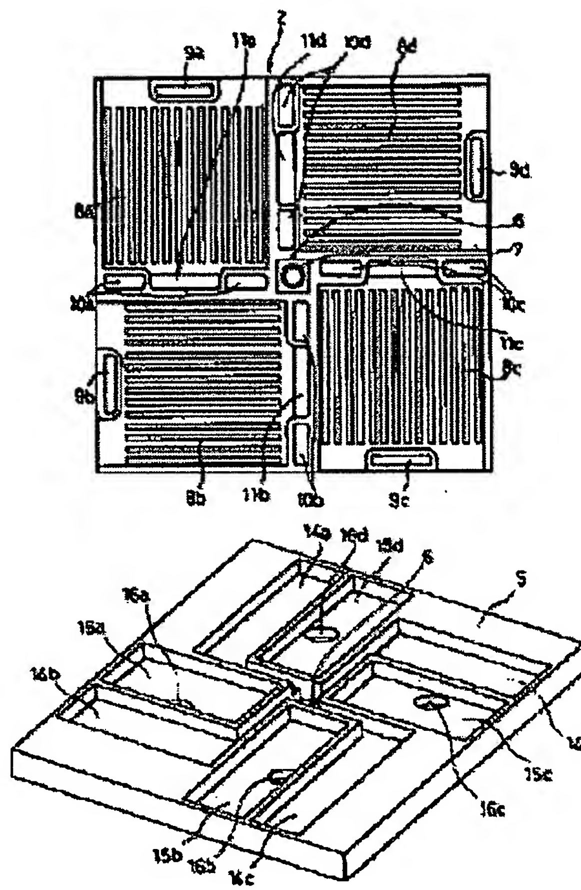
Abstract of **JP7022059**

PURPOSE:To decrease a temperature difference between a center cell and end cells so as to enhance cell life by causing fuel gas to exchange heat with a cell stack as it circulates through a supply line.

CONSTITUTION:Fuel gas supply side buffers 14a-14d are connected to respective internal manifold supply holes 9a-9d and fuel gas discharge side buffers 15a-15d are connected to respective internal manifold discharge holes 10a-10d. Fuel gas discharge holes 16a-16d for discharging fuel gas out of a cell are formed within the respective buffers 15a-15d. The fuel gas rises within a cell stack via a fuel gas preheating pipe 7 at the center of the cell stack, absorbing the heat of the cell and reaching a higher temperature. Heat at the center of a cell plane is absorbed by a gas preheating portion 6, so the fuel gas exchanges heat with the stack as it circulates through the preheating portion 6 serving as a fuel gas supply line. Thereby the temperature difference between the center portion and the peripheral portion of the cell plane is decreased, the fuel gas is efficiently heated, and cell life can be enhanced.



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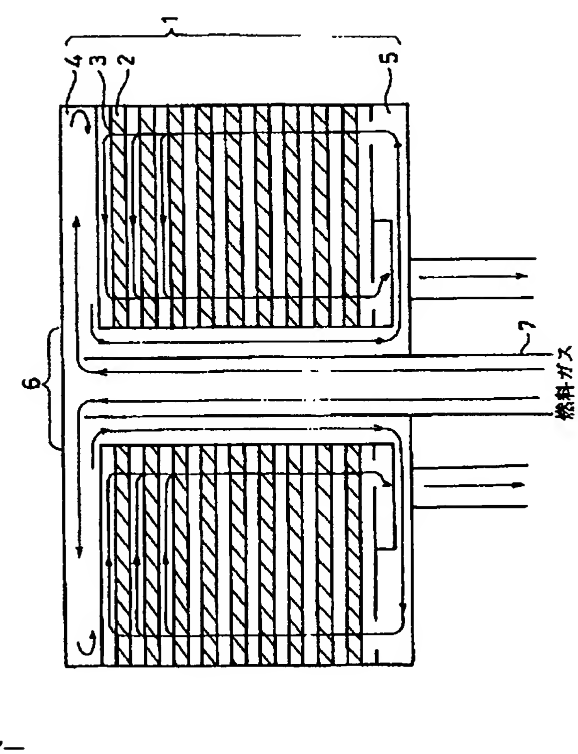
(54)【発明の名称】 平板型固体電解質燃料電池

(57)【要約】

【目的】 コストの増大を抑制すると共に、セル平面の温度差を抑制し、電池寿命が向上した非常に優れた平板型固体電解質燃料電池を提供することを目的とする。

【構成】 電解質板１２ａ～１２ｄの両面に燃料極１３ａ～１３ｄと酸化剤極とを配して成るセル３ａ～３ｄと，セパレータ２とを積層させて電池スタック１を構成する平板型固体電解質燃料電池において、前記電池スタック１の中心部近傍にスタック１内を積層方向に貫通する燃料ガス供給通路６を形成し、該燃料ガス供給通路６内を流通する間に燃料ガスが電池スタック１と熱交換する構成であることを特徴とする。



【特許請求の範囲】

【請求項1】　電解質板の両面に燃料極と酸化剤極とを配して成るセルと，セパレータとを積層させて電池スタックを構成する平板型固体電解質燃料電池において、
前記電池スタックの中心部近傍にスタック内を積層方向に貫通する燃料ガス供給通路を形成し、該燃料ガス供給通路内を流通する間に燃料ガスが電池スタックと熱交換する構成であることを特徴とする平板型固体電解質燃料電池。

【請求項2】　前記燃料ガス供給通路を内外二重構造にすると共に、燃料ガスが内側供給通路と外側供給通路の一方から他方に折り返す状態で流れる構成としたことを特徴とする請求項1記載の平板型固体電解質燃料電池。

【発明の詳細な説明】

【0001】

【産業上の利用分野】本発明は平板型固体電解質燃料電池に関し、詳しくは燃料ガス供給構造の改良に関する。

【0002】

【従来の技術】燃料電池は供給されるガスの化学エネルギーを直接電気エネルギーに変換するので、高い発電効率が期待できる。特に固体電解質燃料電池（ＳＯＦＣ）は、リン酸型燃料電池（ＰＡＦＣ），溶融炭酸塩型燃料電池（ＭＣＦＣ）に次ぐ第三世代の燃料電池として注目されている。

【０００３】一般に、ＳＯＦＣは完全固体化した燃料電池といわれるように、電解質として主に$(ZrO_2)_{0.9}(Y_2O_3)_{0.1}$等の２価又は３価の金属酸化物を固溶した酸化ジルコニウム（安定化ジルコニア）を使用するため、電解質（液）損失の問題がないという利点がある。また、これら電解質の電荷担体は酸素イオンであるが、この酸素イオンの導電率は常温では極めて低く、通常約１０００℃という高温でＳＯＦＣを作動させているので、高品質な排熱が得られる，廃熱の利用を含めると前記ＰＡＦＣやMCFCに比べてエネルギー効率を向上させることができる，燃料ガスの選択の巾が増える，高電流密度で作動させることができる等の利点もある。

【０００４】従来、ＳＯＦＣの開発は円筒型が先行していたが、現在では体積当りの発電効率の増加が見込まれる平板型ＳＯＦＣの開発が脚光を浴びている。また、近年では平板型ＳＯＦＣの高容量化の要請が高まり、そのためセルの大型化（大面積化）が図られている。

【０００５】

【発明が解決しようとする課題】ところで、従来は燃料ガスを外部予熱器等で所定温度まで昇温した後、電池内に供給して発電を行っていたが、セルの大型化に伴い多量の燃料ガスを供給する必要が生じた。したがって、外部予熱器等の能力増大や大型化を図る必要があり、そのためコストの増大を招くという課題があった。

【０００６】また、セルの大面積化に伴って発電時の発熱量が増大し、そのためセル平面での温度差が増大し、セル劣化が早まるという課題もあった。本発明は上記課題に鑑み、コストの増大を抑制すると共に、セル平面の温度差を抑制し、電池寿命が向上した非常に優れた平板型固体電解質燃料電池を提供することを目的とする。

【０００７】

【課題を解決するための手段】本発明は上記課題を解決するため、以下のことを特徴とする。

①　電解質板の両面に燃料極と酸化剤極とを配して成るセルと，セパレータとを積層させて電池スタックを構成する平板型固体電解質燃料電池において、前記電池スタックの中心部近傍にスタック内を積層方向に貫通する燃料ガス供給通路を形成し、該燃料ガス供給通路内を流通する間に燃料ガスが電池スタックと熱交換する構成であることを特徴とする。

②　前記燃料ガス供給通路を内外二重構造にすると共に、燃料ガスが内側供給通路と外側供給通路の一方から他方に折り返す状態で流れる構成としたことを特徴とする。

【０００８】

【作用】上記①の構成によれば、セルの発熱が奪われにくく周辺部に比べて温度が高い電池スタックの中心部近傍に燃料ガス供給通路を形成したので、燃料ガスは前記燃料ガス供給通路内を流れる間にセルの発熱を奪って高温になる。したがって、高温の燃料ガスを各セルに十分に供給することができるので、セルの大型化に伴って燃料ガスの供給量が増加した場合でも、その増加分を従来のように外部予熱器等に依存する必要がない。その結果、外部予熱器等の能力増大や大型化を図る必要がないので、コストの増大を抑制することができる。

【０００９】また、セル平面の中心部の熱は前記燃料ガス通路内を流れる燃料ガスによって奪われるため、セル平面の中心部と周辺部との温度差が抑制され、その結果セル劣化を抑制することができる。更に、上記②の構成によれば、燃料ガスは電池スタック内を積層方向に対向して流れるため、電池スタック内の積層方向での温度差が互いに打ち消され、電池スタックの中央部側セルと端部側セルとの温度差が緩和され、電池寿命も向上する。

【００１０】

【実施例】

〔実施例〕図１は本発明の一実施例に係る平板型固体電解質燃料電池（１０セルスタック）の概略構成を示す模式図であり、この電池スタック１は後述するバイポーラプレート２とセル３とを交互に積層させ、燃料ガスバッファプレート４及びガスコネクタープレート５で挟持した構造である。前記電池スタック１の中央部には積層方向に貫通する燃料ガス予熱部６が形成され、また該燃料ガス予熱部６内はアルミナ等の絶縁性セラミックスから成る燃料ガス予熱管７が積層方向に延設されて二重構造になっている。尚、セル３とバイポーラプレート２、或いは各セル３間の気密は、パイレックスガラス等の非導

電性高粘度融体から成るシール剤（図示せず）を使用した。

【0011】図2はバイポーラプレート2の平面図であり、大きさ250mm×250mmのインコネル600等の耐熱合金から成り、中央部には前記燃料ガス予熱部6が形成されている。また、該プレート2の片面には図に示すようにリブ8a～8dが形成され、該リブ8a～8dによって酸化剤ガス流路が4つの領域に仕切られている。尚、図示しないが、該プレート2の反対側の面にも前記リブ8a～8dと略同一形状のリブが形成され、該リブによって燃料ガス流路が4つの領域に仕切られている。ここで、酸化剤ガスと燃料ガスとはセル内を対向して流れるようになっており、電池反応に寄与した後の温度の高い燃料ガスが電池スタック1の中央部側を流れるように、内部マニホールド供給孔9a～9d及び内部マニホールド排出孔10a～10dが夫々設けられている。尚、図中11a～11dは酸化剤ガスを供給するための内部マニホールド孔を夫々示している。

【0012】図3はセル3の平面図であり、前記バイポーラプレート2と略同じ大きさ（250mm×250mm）である。このセル3は、内部マニホールド孔9a～9d，10a～10d及び11a～11dを形成した電解質板（大きさ100mm×150mm，厚さ0.2mm）12a～12dの両面に、燃料極13a～13d及び酸化剤極（図示せず）を配して成る4枚の単セル3a～3dを組み合わせ、各電解質板12a～12dに形成した内部マニホールド孔を前記バイポーラプレート2のそれと対応させると共に、中央部には前記燃料ガス予熱部6を形成した。このように小型の単セル3a～3d（大きさ100mm×150mm）を複数組み合わせることにより大型のセル3（大きさ250mm×250mm）を構成すれば、強度が脆く壊れやすい電解質板12a～12dの大型化を図ることなくセル3の大面積化を実現できるという利点がある。

【0013】ここで、前記単セル3a～3dを以下のようにして作製した。先ず、3mol%Y_2O_3部分安定化ジルコニア（PSZ）から成る電解質板12a～12dの片面に酸化ニッケル及び8mol%Y_2O_3安定化ジルコニア（YSZ）から成るスラリーをスクリーン印刷法により塗布した後、焼成して燃料極13a～13dを形成した。一方、前記電解質板12a～12dの他方の面にランタンストロンチウムマンガネート（$La_{0.9}Sr_{0.1}MnO_3$）とYSZとから成るスラリーを、スクリーン印刷法により塗布後、焼成して酸化剤極（図示せず）を形成した。

【0014】図4は電池スタック1の下端に設けられるガスコネクタープレート5の斜視図であり、各燃料ガス供給側バッファ14a～14dは各内部マニホールド供給孔9a～9dと連結し、各燃料ガス排出側バッファ15a～15dは各内部マニホールド排出孔10a～10dと連結している。また、この燃料ガス排出側バッファ15a～15d内には燃料ガスを電池外に排出するための燃料ガス排出孔16a～16dが形成されている。

【0015】以下、上記の如く構成された平板型固体電解質燃料電池における燃料ガスの予熱方法について、図1～図4を用いて具体的に説明する。先ず、電池外の外部予熱器（図示せず）によって一定温度まで昇温された燃料ガスは、電池スタック1中央部の燃料ガス予熱管7を介して電池スタック1内を上昇する。ここで、燃料ガス予熱管7が設けられる電池スタック1の中央部はセルの発熱が奪われにくく周辺部に比べて温度が高いので、燃料ガスは前記燃料ガス予熱管7内を流れる間にセルの発熱を奪ってより高温になる。また、セル平面の中心部の発熱は前記燃料ガス予熱部6に奪われるため、セル平面の中心部と周辺部との温度差が抑制される。

【0016】次に、この加熱された燃料ガスは燃料ガスバッファプレート4に入り、電池スタック1上端側の端部セル3に熱を与えた後、燃料ガス予熱部6内（即ち、燃料ガス予熱管7の外周側）を下降し、電池スタック1最下端のガスコネクタープレート5に設けた燃料ガス供給側バッファ14a～14dに供給され、電池スタック1下端側の端部セル3に熱を与える。ここで、前記燃料ガス予熱管7の内周側と外周側とでは、燃料ガスの流れる方向が逆であるので、電池スタック1積層方向の温度差を抑制することができる。加えて、燃料ガスバッファプレート4及び燃料ガス供給側バッファ14a～14d内では燃料ガスが一時的に貯留されるため、電池スタック1上端側の端部セル3及び電池スタック1下端側の端部セル3を加熱し、電池スタック1中央部側セルと端部側セルとの温度差を抑制することもできる。

【0017】続いて、この燃料ガスは内部マニホールド供給孔9a～9dを介して電池スタック1内を上昇する間に、各単セル3a～3dに分配される。そして、電池反応に寄与した後の高温の燃料ガスは内部マニホールド排出孔10a～10dを介して電池スタック1内を下降して、前記ガスコネクタープレート5の燃料ガス排出側バッファ15a～15dに入り、燃料ガス排出孔16a～16dを介して電池外に排出される。この場合、電池スタック1の中央部側には燃料ガスの排出側が設けられているため、中央部の燃料ガス予熱部6に熱を効率的に与えることができる。その結果、この燃料ガス予熱部6及び燃料ガス予熱管7内を流れる燃料ガスを効率よく加熱することができる。

【0018】このように構成された電池スタックを、以下（A）スタックと称する。

〔比較例〕図5は従来の平板型固体電解質燃料電池（10セルスタック）を示す斜視図であり、電解質板31（大きさ200mm×200mm）の両面に上記実施例1と同様にして燃料極32及び酸化剤極（図示せず）を配したセル33と，バイポーラプレート34とを積層させた

構造であり、燃料ガスの予熱は電池外に設けた外部予熱器（図示せず）のみで行った。

【0019】このように構成された電池スタックを、以下（X）スタックと称する。

〔実験1〕上記本発明の（A）スタックと比較例の（X）スタックとを用いて、電流密度とセル面内温度差との関係について調べたので、その結果を図6に示す。尚、実験は一定流量の燃料ガス及び酸化剤ガスを供給し、スタック近傍で電池温度を1000℃に制御した場合における、電池スタックの下から6番目のセルの下面側に接するバイポーラプレートの中央部付近と周辺部との温度差を測定するという条件である。

【0020】図6から明らかなように、比較例の（X）スタックでは電流密度の増大に伴ってセル面内温度差が著しく上昇するのに対して、本発明の（A）スタックでは温度差が比較例の（X）スタックに比べて半分以下に抑制されていることが認められる。この場合、本発明の（A）スタックの電極有効面積は、比較例の（X）スタックのそれに比べてはるかに大きく、発熱量が大きいことからも、本発明の（A）スタックではセル面内の温度差が有効に抑制されていることは明らかである。

【0021】これは、本発明の（A）スタックではセルの発熱が中央部に設けた燃料ガス予熱部での燃料ガスの予熱に有効に利用されるため中央部と周辺部との温度差が抑制されるのに対して、比較例の（X）スタックでは中央部での放熱が起こりにくいためであると思われる。尚、無負荷の状態では、中央部の温度が周辺部より低いため、比較例の（X）スタックに比べ本発明の（A）スタックの方がセル面内温度差が大きくなっているが、実際の使用に際しては、無負荷時はガス流量を少なくするため、この温度差は緩和される。

〔実験2〕上記本発明の（A）スタックと比較例の（X）スタックとを用いて、電流密度と電池スタック積層方向の温度差との関係について調べたので、その結果を図7に示す。尚、実験はバイポーラプレートの中央部付近の温度を測定し、電池スタック内の最大温度と最小温度との温度差について調べ、その他は上記実験1と同様の条件である。

【0022】図7から明らかなように、比較例の（X）スタックにおいては無負荷時でも温度差が大きく、また電流密度の増大に伴ってスタック内温度差も上昇するのに対して、本発明の（A）スタックでは電流密度の増加に係わらず、スタック内温度差が略一定であることが認められる。これは、本発明の（A）スタックでは燃料ガス予熱管の内周側と外周側とで燃料ガスの流れが逆であるため、電池スタック内の積層方向での温度差が互いに打ち消され、電池スタックの中央部側セルと端部側セルとの温度差が抑制されるのに加えて、電池スタックの最上端及び最下端に設けた燃料ガスバッファプレート4及びガスコネクタープレート5に一時的に燃料ガスが貯留されるので、電池スタックの端部側セルの温度が上昇し、積層方向中央部との温度差が抑制されるためであると思われる。

〔その他の事項〕

① 上記実施例においては、燃料ガス予熱部6内を燃料ガス予熱配管7によって二重構造としたが、本発明は何らこれに限定されるものではなく、一重又は三重構造とすることも可能である。しかしながら、二重構造であれば燃料ガスを積層方向に対向して流すことにより、積層方向の温度差を抑制することができるため好ましい。

② また、バイポーラプレート2の材質としてインコネル600等の耐熱合金を使用したが、ランタンクロマイト等の導電性セラミックスを使用することも勿論可能である。

③ 更に、反応ガスを内部マニホールド方式によって供給したが、外部マニホールド方式によって供給することも勿論可能である。

【0023】

【発明の効果】以上の本発明によれば、セルの発熱が奪われにくく周辺部に比べて温度が高い電池スタックの中心部近傍に燃料ガス供給通路を形成したので、燃料ガスは前記燃料ガス供給通路内を流れる間にセルの発熱を奪って高温になる。したがって、高温の燃料ガスを各セルに十分に供給することができるので、セルの大型化に伴って燃料ガスの供給量が増加した場合でも、その増加分を従来のように外部予熱器等に依存する必要がない。その結果、外部予熱器等の能力増大や大型化を図る必要がないので、コストの増大を抑制することができるといった優れた効果を奏する。

【0024】また、セル平面の中心部の熱は前記燃料ガス通路内を流れる燃料ガスによって奪われるため、セル平面の中心部と周辺部との温度差が抑制され、その結果セル劣化を抑制することができる。更に、上記②の構成によれば、燃料ガスは電池スタック内を積層方向に対向して流れるため、電池スタック内の積層方向での温度差が互いに打ち消され、電池スタックの中央部側セルと端部側セルとの温度差が緩和され、電池寿命も向上する。

【図面の簡単な説明】

【図1】本発明の一実施例に係る平板型固体電解質燃料電池（10セルスタック）の概略構成を示す模式図である。

【図2】バイポーラプレートの平面図である。

【図3】セルの平面図である。

【図4】ガスコネクタープレートの斜視図である。

【図5】従来の平板型固体電解質燃料電池（10セルスタック）を示す斜視図である。

【図6】上記本発明の（A）スタックと比較例の（X）スタックとを用いた場合における、電流密度とセル面内温度差1の関係を示すグラフである。

【図7】上記本発明の（A）スタックと比較例の（X）

スタックとを用いた場合における、電流密度と電池スタック積層方向の温度差との関係を示すグラフである。

【符号の説明】

1　電池スタック

2　セパレータ

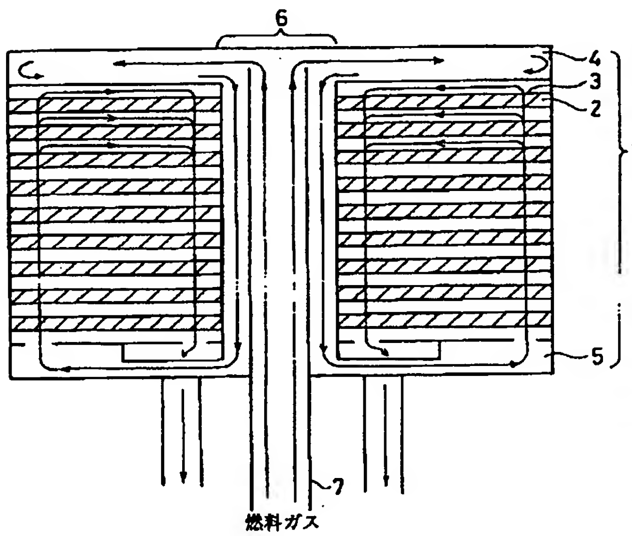
3a～3d　セル

6　燃料ガス供給通路

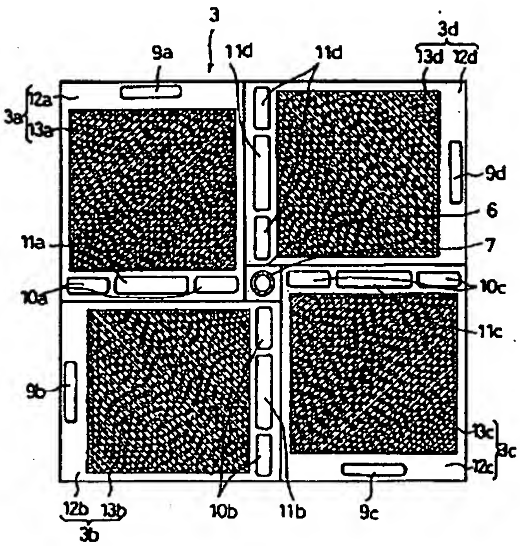
12a～12d　電解質板

13a～13d　燃料極

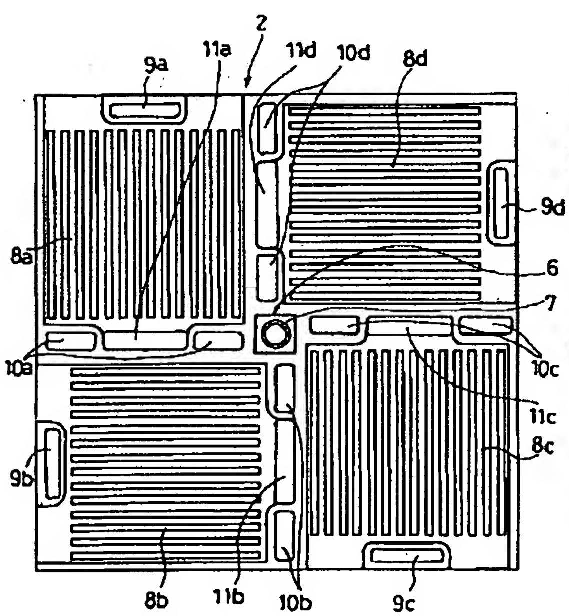
【図1】



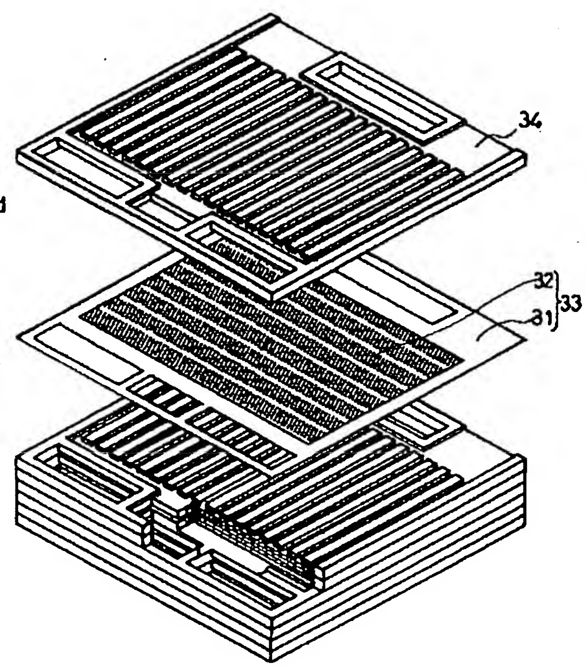
【図3】



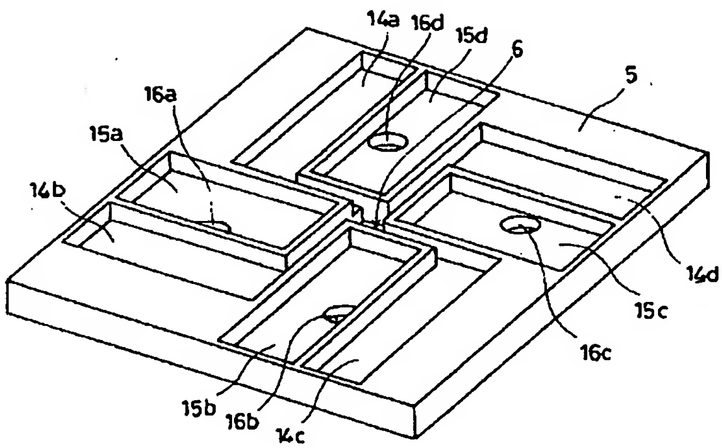
【図2】



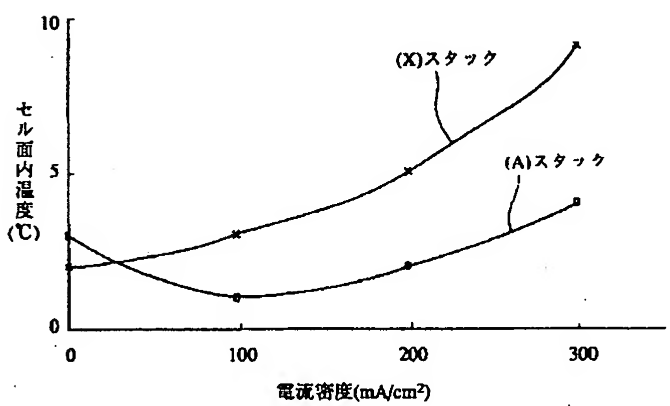
【図5】



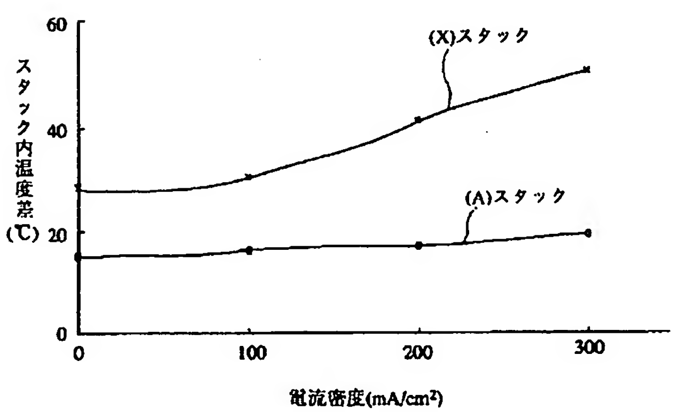
【図4】


14a
16d
15d
6
5
16a
15a
14b
14d
15c
16c
15b
16b
14c

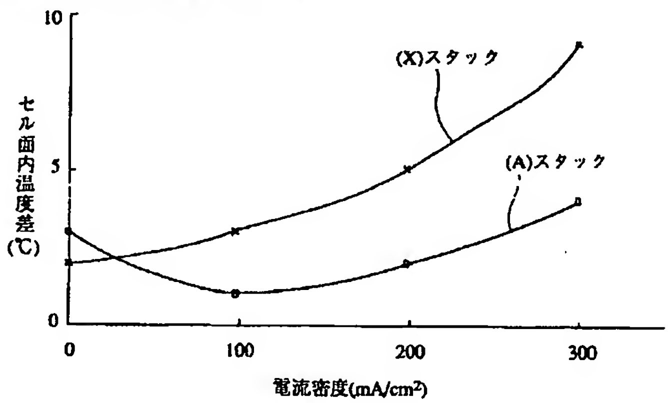
【図6】


(X)スタック
(A)スタック
セル面内温度(℃)
10
5
0
0
100
200
300
電流密度(mA/cm²)

【図7】


(X)スタック
(A)スタック
スタック内温度差(℃)
60
40
20
0
0
100
200
300
電流密度(mA/cm²)

【手続補正書】
【提出日】平成5年9月9日
【手続補正1】
【補正対象書類名】明細書
【補正対象項目名】００１６
【補正方法】変更
【補正内容】
【００１６】次に、この加熱された燃料ガスは燃料ガスバッファプレート４に入り、電池スタック１上端部と熱交換した後、燃料ガス予熱部６内（即ち、燃料ガス予熱管７の外周側）を下降し、電池スタック１最下端のガスコネクタープレート５に設けた燃料ガス供給側バッファ１４ａ～１４ｄに供給され、電池スタック１下端側の端部セル３に熱を与える。ここで、前記燃料ガス予熱管７の内周側と外周側とでは、燃料ガスの流れる方向が逆であるので、電池スタック１積層方向の温度差を抑制することができる。加えて、燃料ガスバッファプレート４及び燃料ガス供給側バッファ１４ａ～１４ｄ内では燃料ガスが一時的に貯留されるため、電池スタック１上端側の端部セル３及び電池スタック１下端側の端部セル３と十分熱交換され、電池スタック１内の温度分布の均熱化が促進される。
【手続補正2】
【補正対象書類名】図面
【補正対象項目名】図6
【補正方法】変更
【補正内容】
【図6】



フロントページの続き

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CLAIMS

[Claim(s)]
[Claim 1]In a monotonous type solid electrolyte fuel cell which makes both sides of an electrolyte plate laminate a cell which allots a fuel electrode and an oxidizing agent pole, and a separator, and constitutes a cell stack, A monotonous type solid electrolyte fuel cell being the composition in which fuel gas carries out heat exchange to a cell stack while forming a fuel gas supply path which penetrates inside of a stack to a laminating direction near the central part of said cell stack and circulating inside of this fuel gas supply path.
[Claim 2]The monotonous type solid electrolyte fuel cell according to claim 1 having made said fuel gas supply path into inside-and-outside dual structure, and having composition which flows in the state where fuel gas turns up on another side from one side of an inside supply path and an outside supply path.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application]This invention relates to improvement of fuel gas supply structure in detail about a monotonous type solid electrolyte fuel cell.
[0002]
[Description of the Prior Art]Since a fuel cell transforms the chemical energy of the gas supplied into electrical energy directly, high generation efficiency is expectable. Especially the solid electrolyte fuel cell (SOFC) attracts attention as a fuel cell of the third generation which ranks second to a phosphoric acid fuel cell (PAFC) and a fused carbonate fuel cell (MCFC).
[0003]In order that SOFC may generally use as an electrolyte the zirconium oxide (stabilized zirconia) which mainly (ZrO_2) dissolved the metallic oxide divalent or trivalent like the fuel cell which carried out full solidification, [, such as $_{0.9}(Y_2O_3)_{0.1}$,] There is an advantage that there is no problem of an electrolyte (liquid) loss. Although the charge carrier of these electrolytes is oxygen ion, Since SOFC is operated at the elevated temperature usually of [the conductivity of this oxygen ion is very low at ordinary temperature, and] about 1000 **, When quality exhaust heat includes the use of waste heat obtained, there is also an advantage of being able to make it that the width of selection of fuel gas increases, operate with high current density, etc. which can raise energy efficiency compared with said PAFC or MCFC.
[0004]Although cylindrical preceded development of SOFC conventionally, development of monotonous type SOFC the increase in the generation efficiency per volume is expected to be is in the limelight now. In recent years, the request of high-capacity-izing of monotonous type SOFC increases, therefore enlargement (large-area-izing) of the cell is attained.
[0005]
[Problem(s) to be Solved by the Invention]By the way, conventionally, after carrying out temperature up of the fuel gas to prescribed temperature with an external preheater etc., it was generating electricity by supplying in a cell, but a lot of fuel gas needed to be supplied with enlargement of a cell. Therefore, capability increase and enlargement of an external preheater etc. needed to be attained, therefore the technical problem that increase of cost was caused occurred.
[0006]The calorific value at the time of power generation increased with large-area-izing of a cell, therefore the temperature gradient in the cell flat surface increased, and the technical problem that cell degradation was brought forward also occurred. This invention controls increase of cost in view of an aforementioned problem, and the temperature gradient of a cell flat surface is controlled and it aims at providing the dramatically outstanding monotonous type solid electrolyte fuel cell whose battery life improved.
[0007]
[Means for Solving the Problem]This invention is characterized by the following things in order to solve an aforementioned problem.

** In a monotonous type solid electrolyte fuel cell which makes both sides of an electrolyte plate laminate a cell which allots a fuel electrode and an oxidizing agent pole, and a separator, and constitutes a cell stack, While forming a fuel gas supply path which penetrates inside of a stack to a laminating direction near the central part of said cell stack and circulating inside of this fuel gas supply path, it is characterized by being the composition in which fuel gas carries out heat exchange to a cell stack.
** Said fuel gas supply path was made into inside-and-outside dual structure, and fuel gas had composition which flows in the state of turning up on another side from one side of an inside supply path and an outside supply path.
[0008]
[Function]Since the fuel gas supply path was formed near the central part of a cell stack with a high temperature compared with the periphery that generation of heat of a cell is hard to be taken according to the composition of the above-mentioned **, while flowing through the inside of said fuel gas supply path, fuel gas takes generation of heat of a cell, and becomes an elevated temperature. Therefore, since hot fuel gas can fully be supplied to each cell, even when the amount of supply of fuel gas increases with enlargement of a cell, it is not necessary to depend for the increment on an external preheater etc. like before. As a result, since it is not necessary to attain capability increase and enlargement of an external preheater etc., increase of cost can be controlled.
[0009]Since the heat of the central part of a cell flat surface is taken by the fuel gas which flows through the inside of said fuel gas passage, a temperature gradient with the central part of a cell flat surface and a periphery is controlled, and, as a result, it can control cell degradation. According to the composition of the above-mentioned **, in order that fuel gas may counter a laminating direction and may flow through the inside of a cell stack, the temperature gradient in the laminating direction in a cell stack is negated mutually, a temperature gradient with the center-section side cell of a cell stack and the end side cell is eased, and its battery life also improves.
[0010]
[Example]
[Example]Drawing 1 is a mimetic diagram showing the outline composition of the monotonous type solid electrolyte fuel cell (ten cell stacks) concerning one example of this invention, This cell stack 1 is the structure which was made to laminate by turns the bipolar plate 2 and the cell 3 which are mentioned later, and was pinched on the fuel gas buffer plate 4 and the gas connector plate 5. The fuel gas preheating part 6 penetrated to a laminating direction is formed in the center section of said cell stack 1, and the fuel gas preheating pipe 7 which comprises insulating ceramics, such as alumina, is installed in a laminating direction, and the inside of this fuel gas preheating part 6 has dual structure. The sealing compound (not shown) which comprises non-conducting hyperviscous melt, such as Pyrex glass, was used for the cell 3, the bipolar plate 2, or the airtightness between each cell 3.
[0011]Drawing 2 is a top view of the bipolar plate 2, the heat-resistant alloy of Inconel 600 grade with a size of 250 mm x 250 mm is comprised, and said fuel gas preheating part 6 is formed in the center section. As shown in a figure, the ribs 8a-8d are formed in one side of this plate 2, and the oxidant gas passage is divided into four fields by these ribs 8a-8d. Although not illustrated, said ribs 8a-8d and the rib of approximately identical shape are formed also in the field of the opposite hand of this plate 2, and the fuel gas flow route is divided into four fields by this rib. Here, the internal manifold feed holes 9a-9d and the internal manifold discharge holes 10a-10d are formed, respectively so that fuel gas with a high temperature after oxidant gas and fuel gas countering, flowing through the inside of a cell and contributing to a cell reaction may flow through the center-section side of the cell stack 1. In the inside 11a-11d of a figure, the internal manifold hole for supplying oxidant gas is shown, respectively.
[0012]drawing 3 is a top view of the cell 3 -- said bipolar plate 2 -- abbreviated -- it is the same size (250 mm x 250 mm). This cell 3 to electrolyte plates [in which the internal manifold holes 9a-9d and 10a-10d and 11a-11d were formed / 12a-12d] (the size of 100 mm x 150 mm, and 0.2 mm in thickness) both sides. The single cells 3a-3d of four sheets which allot the fuel electrodes 13a-13d and an oxidizing agent pole (not shown) were combined, the internal manifold hole formed in each electrolyte plates 12a-12d was made to correspond with it of said bipolar plate 2, and said fuel gas preheating part 6 was

formed in the center section. Thus, if the large-sized cell 3 (size of mm [250] x 250 mm) is constituted by combining two or more small single cells 3a-3d (size of mm [100] x 150 mm), There is an advantage that large area-ization of the cell 3 can be realized without intensity attaining enlargement which is the electrolyte plates 12a-12d which break easily.
[0013]Here, said single cells 3a-3d were produced as follows. First, after applying the slurry which changes from nickel oxide and 8mol%Y_2O_3 stabilized zirconia (YSZ) to electrolyte plates [which comprise 3mol%Y_2O_3 partially stabilized zirconia (PSZ) / 12a-12d] one side with screen printing, It calcinated and the fuel electrodes 13a-13d were formed. On the other hand, the slurry which comprises lantern strontium manganate ($La_{0.9}Sr_{0.1}MnO_3$) and YSZ was calcinated to the field of said electrolyte plates [12a-12d] another side after spreading with screen printing, and the oxidizing agent pole (not shown) was formed in it.
[0014]Drawing 4 is a perspective view of the gas connector plate 5 provided in the lower end of the cell stack 1, Each fuel gas supply side buffers 14a-14d were connected with each internal manifold feed holes 9a-9d, and have connected each fuel gas discharge side buffers 15a-15d with each internal manifold discharge holes 10a-10d. In these fuel gas discharge side buffer 15a-15d, the fuel gas discharge holes 16a-16d for discharging fuel gas out of a cell are formed.
[0015]Hereafter, the preheating method of the fuel gas in the constituted monotonous type solid electrolyte fuel cell is concretely explained using drawing 1 - drawing 4 like the above. First, the fuel gas by which temperature up was carried out goes up the inside of the cell stack 1 via the fuel gas preheating pipe 7 of cell stack 1 center section to constant temperature with the external preheater (not shown) besides a cell. Here, since the center section of the cell stack 1 in which the fuel gas preheating pipe 7 is formed has [that generation of heat of a cell is hard to be taken] a high temperature compared with a periphery, while flowing through the inside of said fuel gas preheating pipe 7, fuel gas takes generation of heat of a cell, and becomes an elevated temperature more. Since generation of heat of the central part of a cell flat surface is taken by said fuel gas preheating part 6, a temperature gradient with the central part of a cell flat surface and a periphery is controlled.
[0016]Next, this heated fuel gas goes into the fuel gas buffer plate 4, The inside of the fuel gas preheating part 6 after giving heat to the end cell 3 by the side of cell stack 1 upper bed. The fuel gas supply side buffers 14a-14d which descended and provided (namely, the periphery side of the fuel gas preheating pipe 7) in the gas connector plate 5 of cell stack 1 lowermost end are supplied, and heat is given to the end cell 3 by the side of cell stack 1 lower end. Here, by the inner circumference [of said fuel gas preheating pipe 7], and periphery side, since the direction into which fuel gas flows is reverse, the temperature gradient of cell stack 1 laminating direction can be controlled. In addition, since fuel gas is temporarily stored within fuel gas buffer plate 4 and fuel gas supply side buffer 14a-14d, The end cell 3 by the side of cell stack 1 upper bed and the end cell 3 by the side of cell stack 1 lower end can be heated, and a temperature gradient with the cell stack 1 center-section side cell and the end side cell can also be controlled.
[0017]Then, this fuel gas is distributed to each single cells 3a-3d, while going up the inside of the cell stack 1 via the internal manifold feed holes 9a-9d. And hot fuel gas after contributing to a cell reaction descends the inside of the cell stack 1 via the internal manifold discharge holes 10a-10d, goes into the fuel gas discharge side buffers 15a-15d of said gas connector plate 5, and is discharged out of a cell via the fuel gas discharge holes 16a-16d. In this case, since the discharge side of fuel gas is provided in the center-section side of the cell stack 1, heat can be efficiently given to the fuel gas preheating part 6 of a center section. As a result, the fuel gas which flows through the inside of this fuel gas preheating part 6 and the fuel gas preheating pipe 7 can be heated efficiently.
[0018]The cell stack constituted in this way is called the (A) stack below.
[Comparative example] Drawing 5 is a perspective view showing the conventional monotonous type solid electrolyte fuel cell (ten cell stacks), It is the structure where the cell 33 which allotted the fuel electrode 32 and the oxidizing agent pole (not shown) to both sides of the electrolyte plate 31 (size of mm [200] x 200 mm) like the above-mentioned Example 1, and the bipolar plate 34 were made to

laminate, and only the external preheater (not shown) formed out of the cell performed preheating of fuel gas.

[0019]The cell stack constituted in this way is called a (X) stack below.

[Experiment 1] Since it investigated using the (A) stack of above-mentioned this invention, and the (X) stack of a comparative example about the relation between current density and a cell face internal temperature degree difference, the result is shown in drawing 6. Experiments are the conditions of measuring a temperature gradient with near the center section of the bipolar plate and the periphery which touch the 6th undersurface side of a cell from under the cell stack at the time of supplying the fuel gas and oxidant gas of constant flow, and controlling battery temperature at 1000 ** near the stack.

[0020]In the (X) stack of a comparative example, it is admitted at the (A) stack of this invention to a cell face internal temperature degree difference going up remarkably with increase of current density that the temperature gradient is controlled below at half compared with the (X) stack of a comparative example so that clearly from drawing 6. In this case, in the (A) stack of this invention, it is clear also from it being far large compared with it of the (X) stack of a comparative example, and calorific value being large that the active electrode area's of the (A) stack of this invention the temperature gradient within a cell face is controlled effectively.

[0021]This is considered to be for heat dissipation in a center section not to take place easily in the (X) stack of a comparative example to a temperature gradient with a center section and a periphery being controlled since generation of heat of a cell is used effective in preheating of the fuel gas in the fuel gas preheating part provided in the center section by the (A) stack of this invention. In the no-load state, since the temperature of a center section is lower than a periphery, in the direction of the (A) stack of this invention, compared with the (X) stack of a comparative example, the cell face internal temperature degree difference is large, but in order to lessen a gas mass flow on the occasion of actual use at the time of no-load, this temperature gradient is eased.

[Experiment 2] Since it investigated using the (A) stack of above-mentioned this invention, and the (X) stack of a comparative example about the relation between current density and the temperature gradient of a cell stack laminating direction, the result is shown in drawing 7. An experiment measures the temperature near the center section of the bipolar plate, and investigates it about a temperature gradient with the maximum temperature in a cell stack, and the minimum temperature, and others are the same conditions as the above-mentioned experiment 1.

[0022]In the (X) stack of a comparative example, also in the time of no-load, a temperature gradient is large and it is admitted irrespective of the increase in current density at the (A) stack of this invention to a stack internal temperature degree difference going up with increase of current density that a stack internal temperature degree difference is approximately regulated so that clearly from drawing 7. By the (A) stack of this invention, this by the inner circumference [of a fuel gas preheating pipe], and periphery side Since the flow of fuel gas is reverse, The temperature gradient in the laminating direction in a cell stack is negated mutually, and it adds to a temperature gradient with the center-section side cell of a cell stack and the end side cell being controlled, Since fuel gas is temporarily stored by the fuel gas buffer plate 4 and the gas connector plate 5 which were provided in the Mogami end and lowermost end of the cell stack, the temperature of the end side cell of a cell stack rises, and it seems that it is because a temperature gradient with a laminating direction center section is controlled.

[Other matters]

** In the above-mentioned example, although the inside of the fuel gas preheating part 6 was made into dual structure by the fuel gas preheating piping 7, it is also possible for this invention not to be limited to this at all, and to consider it as one layer or threefold structure. However, since the temperature gradient of a laminating direction can be controlled by countering a laminating direction and passing fuel gas if it is dual structure, it is desirable.

** Although the heat-resistant alloy of the Inconel 600 grade was used as construction material of the bipolar plate 2, of course, it is also possible again to use electrically conductive ceramics, such as lanthanum chromite.

** Although reactant gas was supplied with the internal manifold type, of course, supplying with an

external manifold type is also still more possible.
[0023]
[Effect of the Invention]In the above this invention, the fuel gas supply path was formed near the central part of a cell stack with a high temperature compared with the periphery that generation of heat of a cell is hard to be taken.
Therefore, while flowing through the inside of said fuel gas supply path, fuel gas takes generation of heat of a cell, and becomes an elevated temperature.
Therefore, since hot fuel gas can fully be supplied to each cell, even when the amount of supply of fuel gas increases with enlargement of a cell, it is not necessary to depend for the increment on an external preheater etc. like before. As a result, since it is not necessary to attain capability increase and enlargement of an external preheater etc., the outstanding effect that increase of cost can be controlled is done so.
[0024]Since the heat of the central part of a cell flat surface is taken by the fuel gas which flows through the inside of said fuel gas passage, a temperature gradient with the central part of a cell flat surface and a periphery is controlled, and, as a result, it can control cell degradation. According to the composition of the above-mentioned **, in order that fuel gas may counter a laminating direction and may flow through the inside of a cell stack, the temperature gradient in the laminating direction in a cell stack is negated mutually, a temperature gradient with the center-section side cell of a cell stack and the end side cell is eased, and its battery life also improves.

[Translation done.]

TECHNICAL FIELD

[Industrial Application]This invention relates to improvement of fuel gas supply structure in detail about a monotonous type solid electrolyte fuel cell.

[Translation done.]

PRIOR ART

[Description of the Prior Art]Since a fuel cell transforms the chemical energy of the gas supplied into electrical energy directly, high generation efficiency is expectable. Especially the solid electrolyte fuel cell (SOFC) attracts attention as a fuel cell of the third generation which ranks second to a phosphoric acid fuel cell (PAFC) and a fused carbonate fuel cell (MCFC).
[0003]In order that SOFC may generally use as an electrolyte the zirconium oxide (stabilized zirconia) which mainly (ZrO_2) dissolved the metallic oxide divalent or trivalent like the fuel cell which carried out full solidification, [, such as $_{0.9}(Y_2O_3)_{0.1}$,] There is an advantage that there is no problem of an electrolyte (liquid) loss. Although the charge carrier of these electrolytes is oxygen ion, Since SOFC is operated at the elevated temperature usually of [the conductivity of this oxygen ion is very low at ordinary temperature, and] about 1000 **, When quality exhaust heat includes the use of waste heat obtained, there is also an advantage of being able to make it that the width of selection of fuel gas increases, operate with high current density, etc. which can raise energy efficiency compared with said PAFC or MCFC.
[0004]Although cylindrical preceded development of SOFC conventionally, development of monotonous type SOFC the increase in the generation efficiency per volume is expected to be is in the limelight now. In recent years, the request of high-capacity-izing of monotonous type SOFC increases, therefore enlargement (large-area-izing) of the cell is attained.

[Translation done.]

EFFECT OF THE INVENTION

[Effect of the Invention]In the above this invention, the fuel gas supply path was formed near the central part of a cell stack with a high temperature compared with the periphery that generation of heat of a cell is hard to be taken.
Therefore, while flowing through the inside of said fuel gas supply path, fuel gas takes generation of heat of a cell, and becomes an elevated temperature.
Therefore, since hot fuel gas can fully be supplied to each cell, even when the amount of supply of fuel gas increases with enlargement of a cell, it is not necessary to depend for the increment on an external preheater etc. like before. As a result, since it is not necessary to attain capability increase and enlargement of an external preheater etc., the outstanding effect that increase of cost can be controlled is done so.
[0024]Since the heat of the central part of a cell flat surface is taken by the fuel gas which flows through the inside of said fuel gas passage, a temperature gradient with the central part of a cell flat surface and a periphery is controlled, and, as a result, it can control cell degradation. According to the composition of the above-mentioned **, in order that fuel gas may counter a laminating direction and may flow through the inside of a cell stack, the temperature gradient in the laminating direction in a cell stack is negated mutually, a temperature gradient with the center-section side cell of a cell stack and the end side cell is eased, and its battery life also improves.

[Translation done.]

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention]By the way, conventionally, after carrying out temperature up of the fuel gas to prescribed temperature with an external preheater etc., it was generating electricity by supplying in a cell, but a lot of fuel gas needed to be supplied with enlargement of a cell. Therefore, capability increase and enlargement of an external preheater etc. needed to be attained, therefore the technical problem that increase of cost was caused occurred.
[0006]The calorific value at the time of power generation increased with large-area-izing of a cell, therefore the temperature gradient in the cell flat surface increased, and the technical problem that cell degradation was brought forward also occurred. This invention controls increase of cost in view of an aforementioned problem, and the temperature gradient of a cell flat surface is controlled and it aims at providing the dramatically outstanding monotonous type solid electrolyte fuel cell whose battery life improved.

[Translation done.]

MEANS

[Means for Solving the Problem]This invention is characterized by the following things in order to solve an aforementioned problem.
** In a monotonous type solid electrolyte fuel cell which makes both sides of an electrolyte plate laminate a cell which allots a fuel electrode and an oxidizing agent pole, and a separator, and constitutes a cell stack, While forming a fuel gas supply path which penetrates inside of a stack to a laminating direction near the central part of said cell stack and circulating inside of this fuel gas supply path, it is characterized by being the composition in which fuel gas carries out heat exchange to a cell stack.
** Said fuel gas supply path was made into inside-and-outside dual structure, and fuel gas had composition which flows in the state of turning up on another side from one side of an inside supply path and an outside supply path.

[Translation done.]

OPERATION

[Function]Since the fuel gas supply path was formed near the central part of a cell stack with a high temperature compared with the periphery that generation of heat of a cell is hard to be taken according to the composition of the above-mentioned **, while flowing through the inside of said fuel gas supply path, fuel gas takes generation of heat of a cell, and becomes an elevated temperature. Therefore, since hot fuel gas can fully be supplied to each cell, even when the amount of supply of fuel gas increases with enlargement of a cell, it is not necessary to depend for the increment on an external preheater etc. like before. As a result, since it is not necessary to attain capability increase and enlargement of an external preheater etc., increase of cost can be controlled.
[0009]Since the heat of the central part of a cell flat surface is taken by the fuel gas which flows through the inside of said fuel gas passage, a temperature gradient with the central part of a cell flat surface and a periphery is controlled, and, as a result, it can control cell degradation. According to the composition of the above-mentioned **, in order that fuel gas may counter a laminating direction and may flow through the inside of a cell stack, the temperature gradient in the laminating direction in a cell stack is negated mutually, a temperature gradient with the center-section side cell of a cell stack and the end side cell is eased, and its battery life also improves.

[Translation done.]

JAPANESE [JP,07-022059,A]

CLAIMS DETAILED DESCRIPTION TECHNICAL FIELD PRIOR ART EFFECT OF THE INVENTION TECHNICAL PROBLEM MEANS OPERATION EXAMPLE DESCRIPTION OF DRAWINGS DRAWINGS WRITTEN AMENDMENT

[Translation done.]

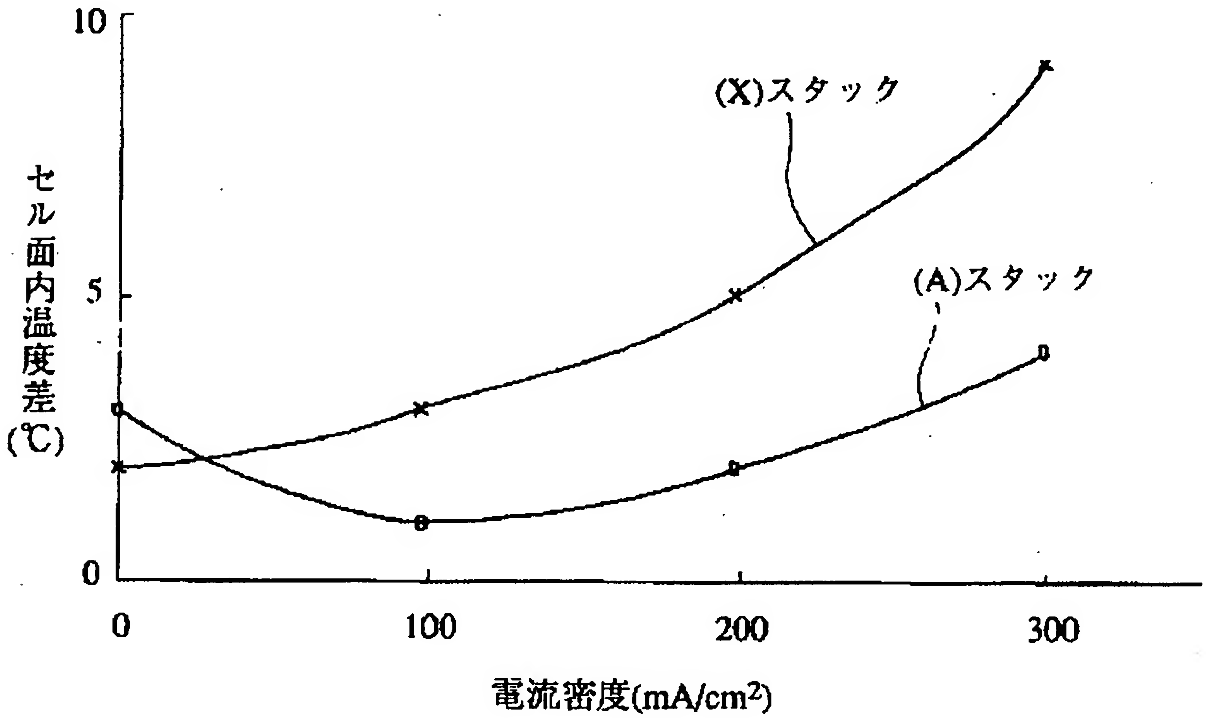
DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1]It is a mimetic diagram showing the outline composition of the monotonous type solid electrolyte fuel cell (ten cell stacks) concerning one example of this invention.
[Drawing 2]It is a top view of a bipolar plate.
[Drawing 3]It is a top view of a cell.
[Drawing 4]It is a perspective view of a gas connector plate.
[Drawing 5]It is a perspective view showing the conventional monotonous type solid electrolyte fuel cell (ten cell stacks).
[Drawing 6]It is a graph which shows the current density at the time of using the (A) stack of above-mentioned this invention, and the (X) stack of a comparative example, and the relation of the cell face internal temperature degree difference 1.
[Drawing 7]It is a graph which shows the relation between the current density at the time of using the (A) stack of above-mentioned this invention, and the (X) stack of a comparative example, and the temperature gradient of a cell stack laminating direction.
[Description of Notations]
1 Cell stack
2 Separator
3a-3d Cell
6 Fuel gas supply path
12a-12d Electrolyte plate
13a-13d Fuel electrode

[Translation done.]

WRITTEN AMENDMENT

[Written amendment]
[Filing date]September 9, Heisei 5
[Amendment 1]
[Document to be Amended]Specification
[Item(s) to be Amended]0016
[Method of Amendment]Change
[Proposed Amendment]
[0016]Next, this heated fuel gas goes into the fuel gas buffer plate 4, After carrying out heat exchange to a cell stack 1 upper-bed part, the fuel gas supply side buffers 14a-14d which descended and established the inside (namely, the periphery side of the fuel gas preheating pipe 7) of the fuel gas preheating part 6 in the gas connector plate 5 of cell stack 1 lowermost end are supplied, and heat is given to the end cell 3 by the side of cell stack 1 lower end. Here, by the inner circumference [of said fuel gas preheating pipe 7], and periphery side, since the direction into which fuel gas flows is reverse, the temperature gradient of cell stack 1 laminating direction can be controlled. In addition, within fuel gas buffer plate 4 and fuel gas supply side buffer 14a-14d, since fuel gas is stored temporarily, heat exchange is enough carried out to the end cell 3 by the side of cell stack 1 upper bed, and the end cell 3 by the side of cell stack 1 lower end, and soak-ization of the temperature distribution in the cell stack 1 is promoted.
[Amendment 2]
[Document to be Amended]DRAWINGS
[Item(s) to be Amended]Drawing 6
[Method of Amendment]Change
[Proposed Amendment]
[Drawing 6]



[Translation done.]